APPLICATION NO. 09/826,118

TITLE OF INVENTION: Wavelet Multi-Resolution Waveforms

INVENTOR: Urbain A. von der Embse

Clean version of how the CLAIMS will read.

APPLICATION NO. 09/829,118
INVENTION: Wavelet Multi-Resolution Waveforms
INVENTORS: Urbain A. von der Embse

CLAIMS

WHAT IS CLAIMED IS:

Claim 1. (deleted)

Claim 2. (deleted)

Claim 4. (deleted)

Claim 5. (deleted_

Claim 6. (deleted)

Claim 7. (currently amended) A least-squares method for generating and applying Wavelet waveforms and filters, said method comprising the steps:

said Wavelet is a digital finite impulse response waveform at baseband in the time domain,

linear phase finite impulse response filter requirements on the passband and stopband performance of the power spectral density are specified by linear quadratic error metrics in the Wavelet,

Wavelet requirements on the deadband for quadrature mirror filter properties required for perfect reconstruction are specified by a linear quadratic error metric in the Wavelet,

Wavelet orthogonality requirements for intersymbol interference and adjacent channel interference are specified by non-linear quadratic error metrics in the Wavelet,

non-linear quadratic error metrics have quadratic coefficients dependent on the Wavelet,

APPLICATION NO. 09/829,118
INVENTION: Multi-Resolution Waveforms
INVENTORS: Urbain A. von der Embse

CLAIMS

WHAT IS CLAIMED IS:

Claim 1. (deleted)

Claim 2. (deleted)

Claim 4. (deleted)

Claim 5. (deleted_

Claim 6. (deleted)

Claim **7**. (currently amended) A least-squares method for generating and applying Wavelet waveforms and filters, said method comprising the steps:

said Wavelet is a digital finite impulse response waveform at baseband in the time domain,

linear phase finite impulse response filter requirements on the passband and stopband performance of the power spectral density are specified by linear quadratic error metrics in the Wavelet,

Wavelet requirements on the deadband for quadrature mirror filter properties required for perfect reconstruction are specified by a linear quadratic error metric in the Wavelet,

Wavelet orthogonality requirements for intersymbol interference and adjacent channel interference are specified by non-linear quadratic error metrics in the Wavelet,

non-linear quadratic error metrics have quadratic coefficients dependent on the Wavelet,

Wavelet multi-resolution property requires said error metrics to be converted to error metrics in the discrete Fourier transform harmonics of the Wavelet which harmonics are the Wavelet impulse response in the frequency domain,

using a least-squares recursive solution algorithm in figures 4,5 with quadratic error metrics, which algorithm requires a means to find the Wavelet harmonics that minimize the sum of said linear quadratic error metrics, an example means being the eigenvalue algorithm,

said harmonics are used to linearize said non-linear quadratic error metrics,

said least-squares recursive solution algorithm finds the harmonics which minimize the weighted sum of the linear and linearized quadratic error metrics,

said least-squares recursive solution algorithm starts over again by using said harmonics to linearize the non-linear error metrics and to find the corresponding harmonics which minimize the sum of said linear and linearized quadratic error metrics,

said least-squares recursive solution algorithm continues to be repeated until the solution converges to the design harmonics of the Wavelet which is the least-squares error solution, and

said Wavelet impulse responses in the time domain and frequency domain are implemented in communication systems for waveforms and filters.

Claim **8**. (currently amended) A second least-squares method for generating and applying Wavelet waveforms and filters, said method comprising the steps:

linear phase filter requirements on the passband and stopband performance of the power spectral density are specified by linear quadratic error metrics in the Wavelet impulse response in the time domain,

using a least-squares recursive solution algorithm in figures 4,5 with norm-squared error metrics, which algorithm requires a initialization Wavelet and a means to find the Wavelet harmonics which minimize the sum of said linear norm-squared error metrics, an example means being a gradient search algorithm,

said initialization Wavelet is the optimum Wavelet that minimizes the weighted sum of said linear quadratic error metrics which optimum Wavelet is found using an eigenvalue, Remez-Exchange, or other optimization algorithm,

said linear quadratic error metrics are transformed into linear norm-squared error metrics in the Wavelet,

Wavelet requirements on the deadband for quadrature mirror filter properties required for perfect reconstruction are specified by a linear norm-squared error metric in the Wavelet,

Wavelet orthogonality requirements for intersymbol interference and adjacent channel interference are specified by non-linear norm-squared error metrics in the Wavelet,

non-linear norm-squared error metrics have norm coefficients dependent on the Wavelet,

Wavelet multi-resolution property requires said error metrics to be converted to error metrics in the discrete Fourier transform harmonics of the Wavelet which harmonics are the Wavelet impulse response in the frequency domain,

using said least-squares recursive solution algorithm to find the harmonics that minimize the weighted sum of said least-squares linear and non-linear norm-squared error metrics, which harmonics are the design harmonics of the Wavelet least-squares error solution, and

said Wavelet impulse responses in the time domain and frequency domain are implemented in communication systems for waveforms and filters.

Claim **9.** (deleted)

Claim **10.** (currently amended) Wherein applications of the Wavelet waveforms and filters in claims 7 or 8, comprising:

Wavelet design in the frequency domain allows a mother Wavelet to be re-scaled for application to multi-channel polyphase filter banks by implementing equations (11),(18),(20) which derive a multi-resolution Wavelet from a mother Wavelet by using the design harmonics of the mother Wavelet and the multi-scale parameters of the Wavelet impulse response for said application,

wherein mother Wavelet refers to a Wavelet at baseband which is used to generate other Wavelets,

wherein multi-scale parameters are the traditional scale, translation, timing parameters, plus the new frequency, spacing, and length parameters of this invention,

scale parameter scales the sampling time interval, the sub-sampling, the over-sampling, and the translation interval between Wavelets,

translation parameter is the timing offset of the Wavelets in units of the spacing parameter,

timing parameter is the digital sampling interval,

frequency parameter is a frequency offset which translates the Wavelet in frequency,

spacing parameter is the number of digital samples for Wavelet spacing which is equal to the number of channels in a polyphase filter bank with a Nyquist sampling rate,

length parameter specifies the length of the Wavelet in the sampling domain, and

said multi-scale parameters and the mother Wavelet design harmonics generate the Wavelet for the multi-channel polyphase filter bank.

Claim **11.** (deleted)

Claim **12**. (currently amended) Wherein properties of Wavelet waveforms and filters in claims 7 or 8, comprising:

said Wavelets are multi-resolution Wavelets which enable a single Wavelet design at baseband to be used to generate Wavelets for multi-resolution applications by implementing equations (11),(18)(20) and using the Wavelet design harmonics and the multi-scale parameters for the multi-resolution Wavelet applications, said Wavelet can be designed for a communications waveform with no excess bandwidth,

said multi-resolution Wavelets are designed to behave like an accordion in that at different scales the Wavelet is a stretched or compressed version of the Wavelet with appropriate time and frequency translation as disclosed on page 21,

said linear waveform and filter least-squares design methods can be modified to design non-linear Wavelet waveforms for other applications including bandwidth efficient modulation and synthetic aperture radar as demonstrated in figures 7,8, and

other optimization algorithms exist for finding said Wavelets.